

Constraining Ozone by Assimilating MLS and OMI Data

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Objectives

Produce accurate global ozone analyses from “stripes” of total ozone from OMI and stratospheric profiles from MLS

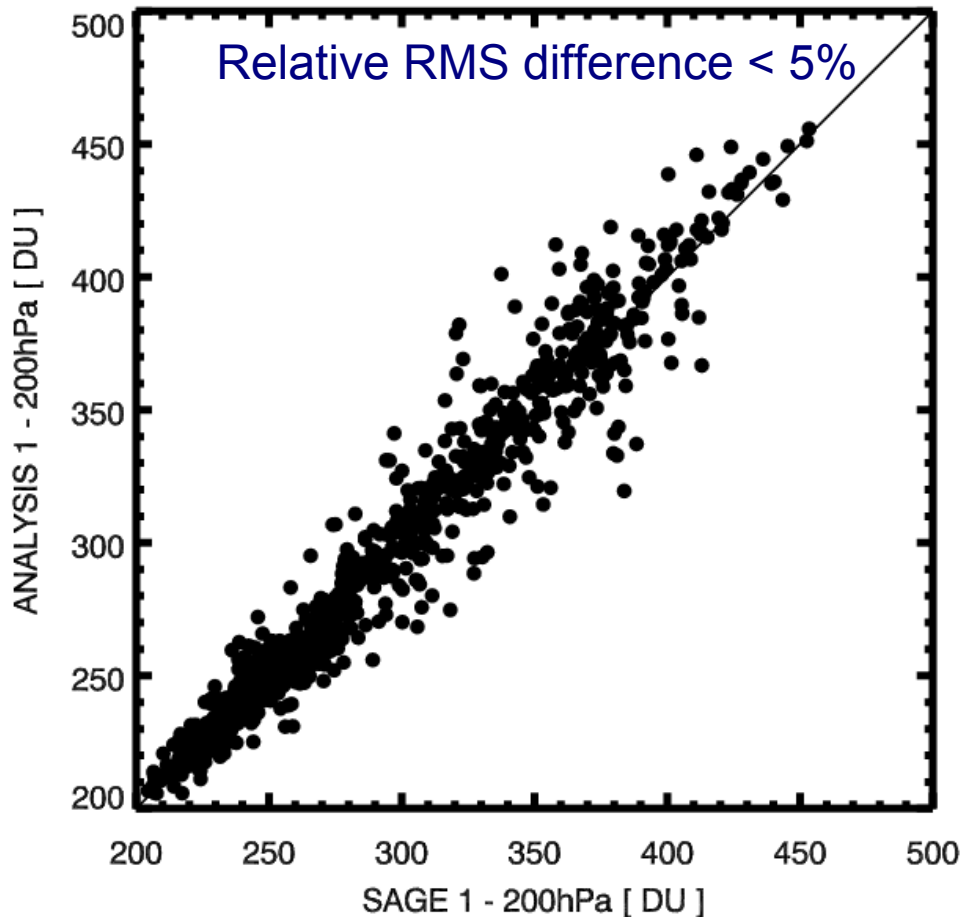
Some reasons:

- Improve knowledge of stratospheric structures
- Estimates of tropospheric ozone columns
- Understanding of ozone structure in UTLS

Today's goal:

- Demonstrate the way in which the assimilation leads to accurate ozone distributions in the UTLS

Stratospheric Ozone Column: Assimilated MLS+OMI -vs- SAGE II



Assimilation into GEOS-4 DAS

Ozone decoupled from
meteorology

Model includes P&L chemistry

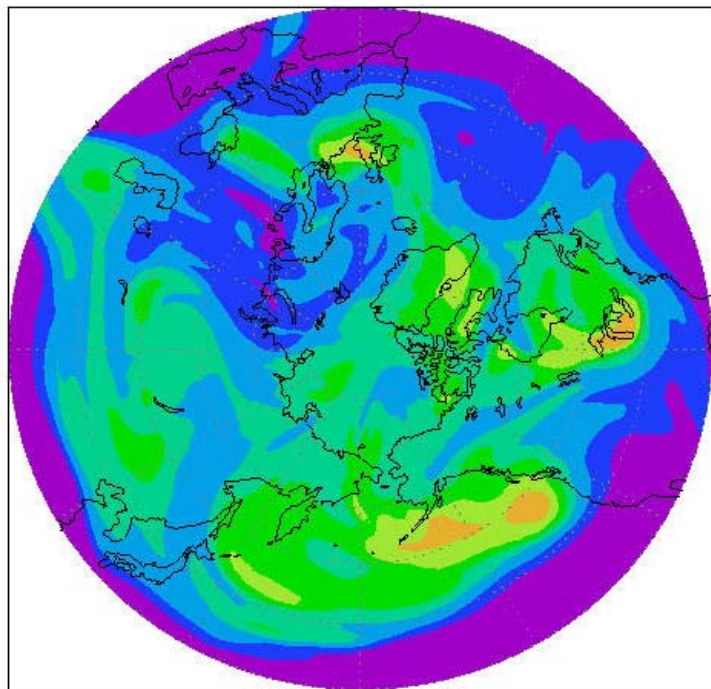
MLS concentrations at 20 levels
(216 - 0.14hPa)

Error estimates provided with
retrievals

OMI data super-obbed to a $2^\circ \times 2.5^\circ$
resolution

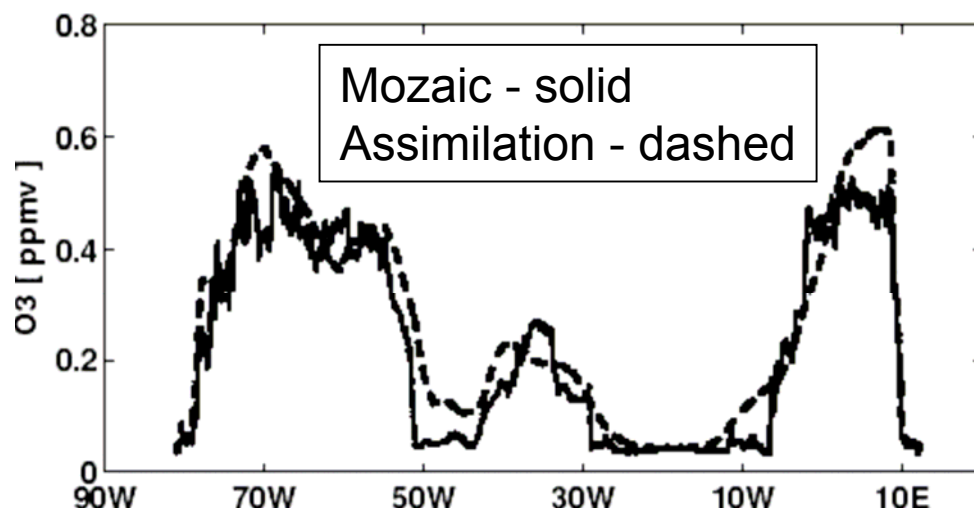
Good agreement between 200-
1hPa partial columns in
assimilation and SAGE-II data

Structure in the Assimilated Ozone



Snapshot of ozone at 200hPa shows a rich structure, even with a model resolution of $1^\circ \times 1.25^\circ$

Comparison with one MOZAIC flight reveals broad alignment of features with the in-situ measurements



The structure in assimilated UTLS ozone is realistic when OMI+MLS data are used in GEOS-4, where the transport properties are demonstrably reasonable

How Does Ozone Structure Arise?*

Alternatives:

- a) Assimilation constrains the largest scales and transport introduces structure
- b) Assimilation corrects the locations of small-scale features introduced by transport

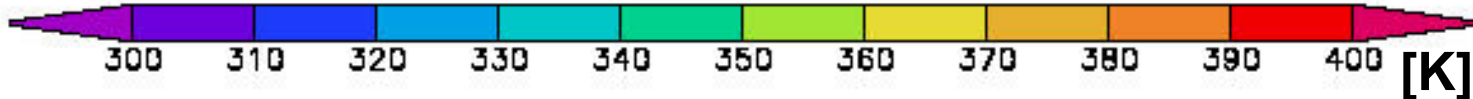
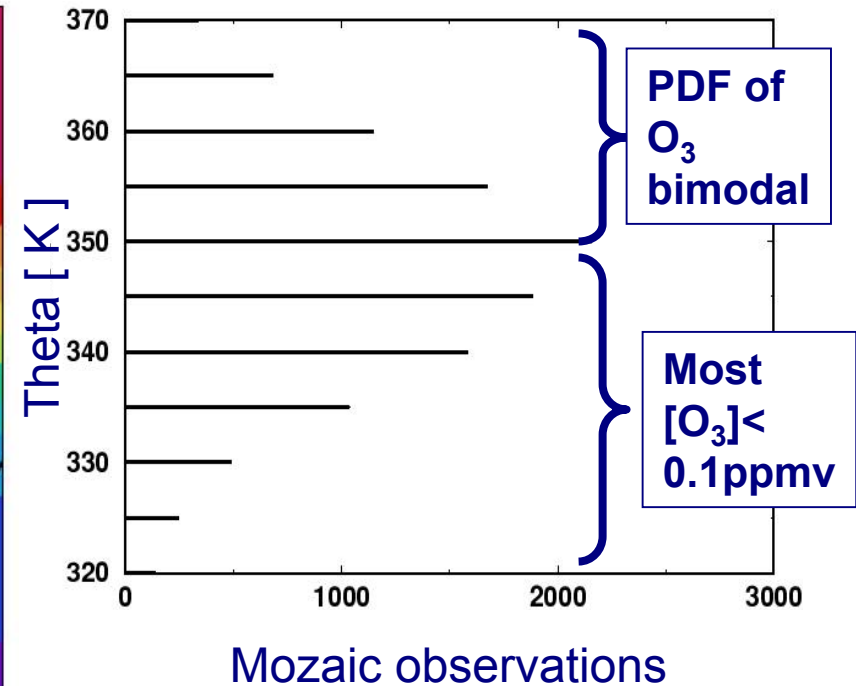
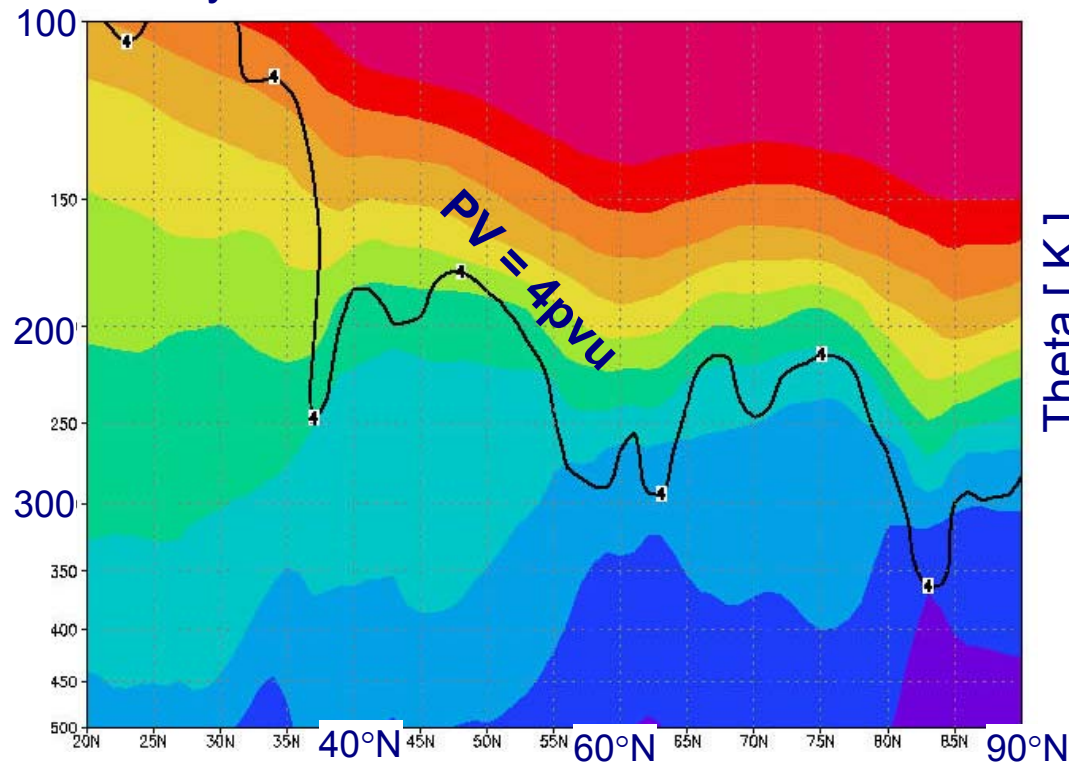
Experiments:

Use unconstrained (modeled) ozone and assimilated ozone in an otherwise identical system (transport with analyzed meteorology in GEOS-4 GCM)

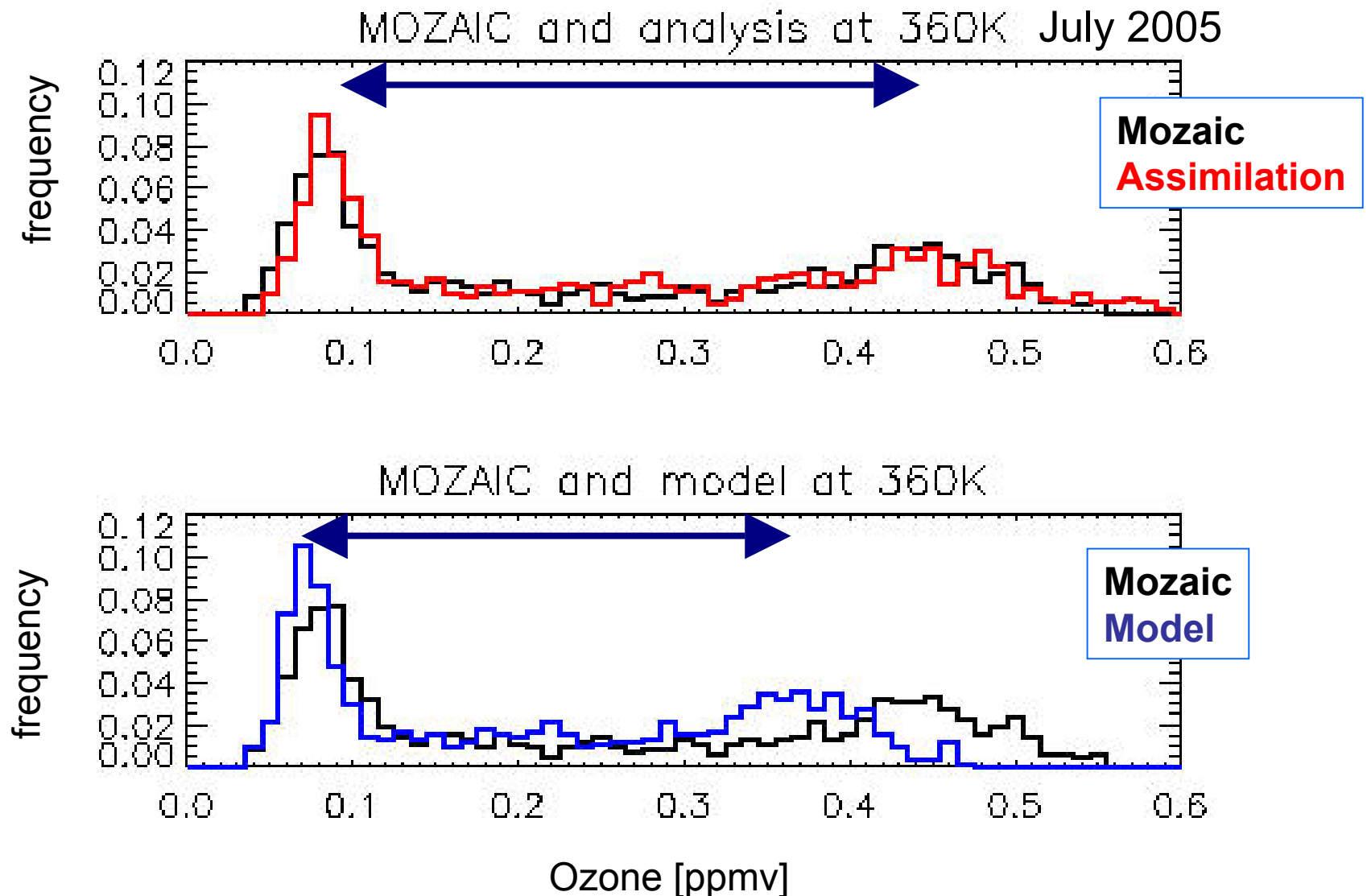
* Alternately: “The Origin of Pieces”

MOZAIC Sampling in UTLS

July 1st 90W - 0° mean PV and Theta

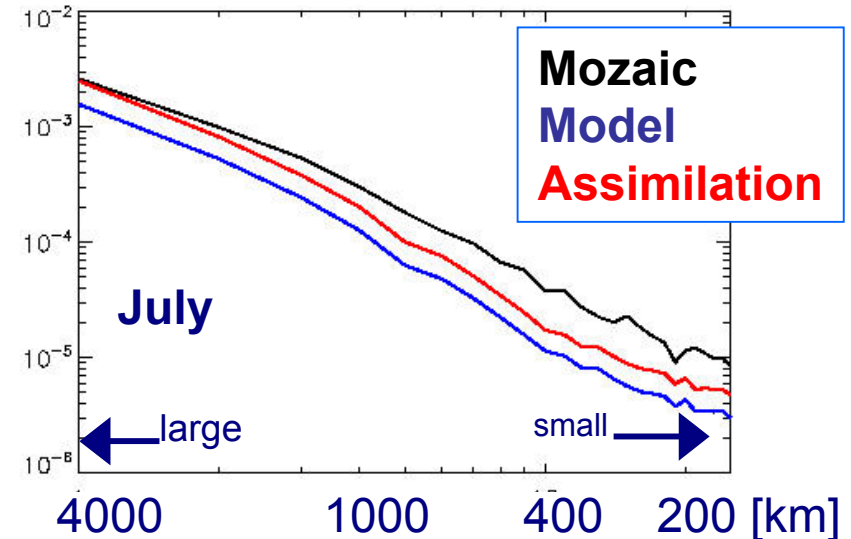
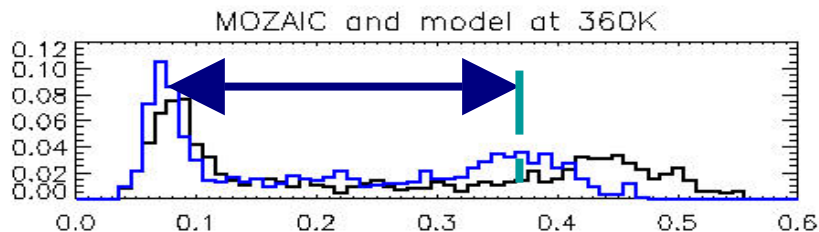
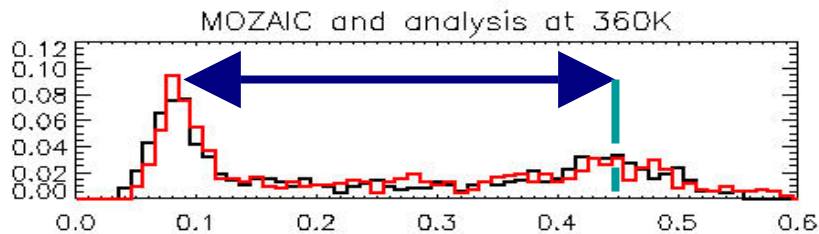


Distribution of ozone in the UTLS



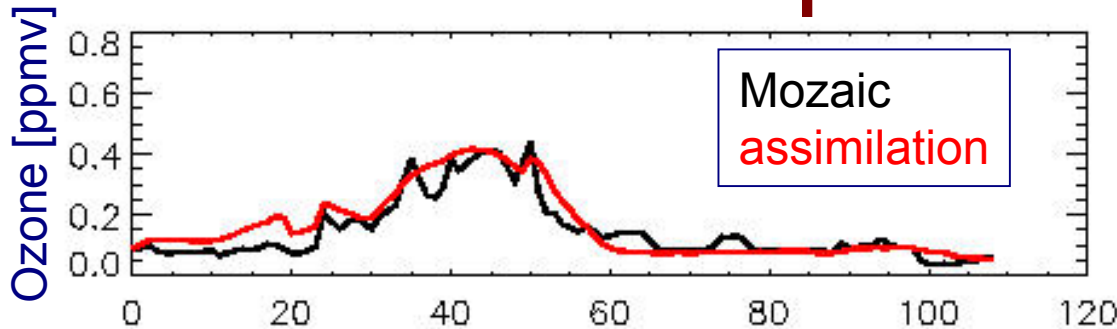
Variability: Power Spectra

Power spectra of ozone mixing ratio calculated from 4000-km long flight segments and interpolated model/analysis

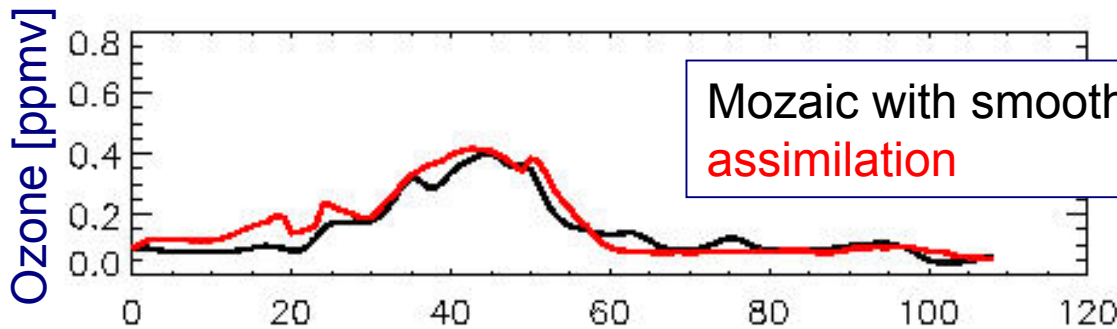


- Variability is underestimated in model and analysis
- Higher amplitudes in assimilation are likely a reflection of reduced bias
- Model and assimilation show the same slope

What Spatial Scales are Captured?

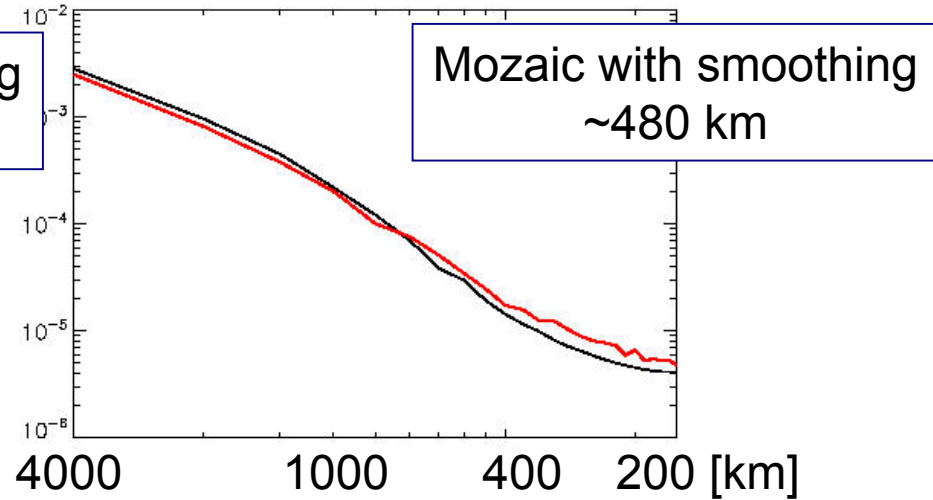
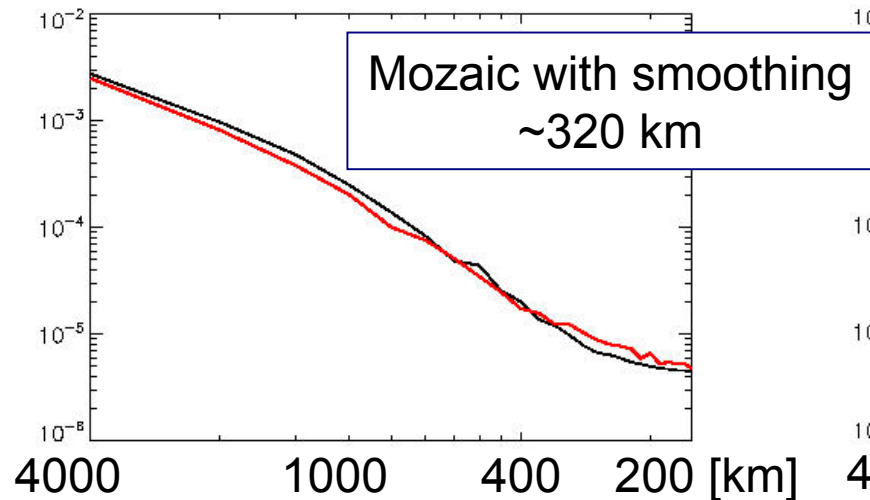
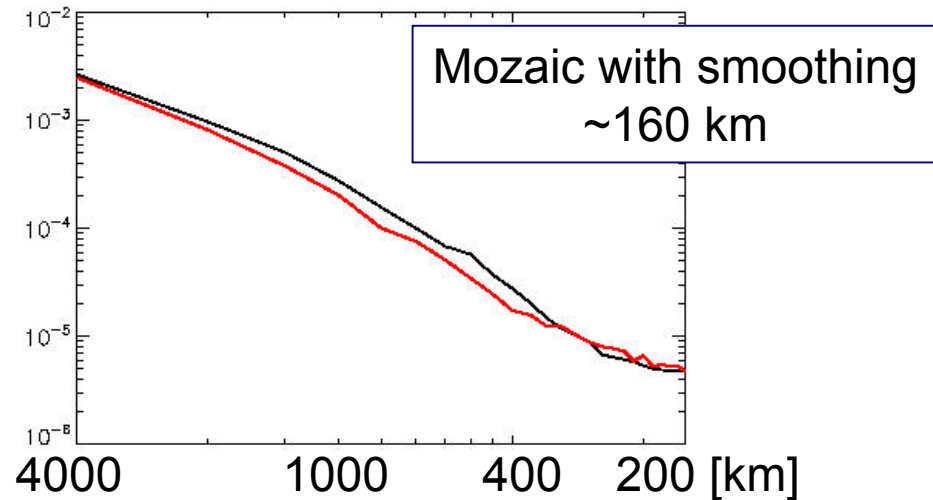
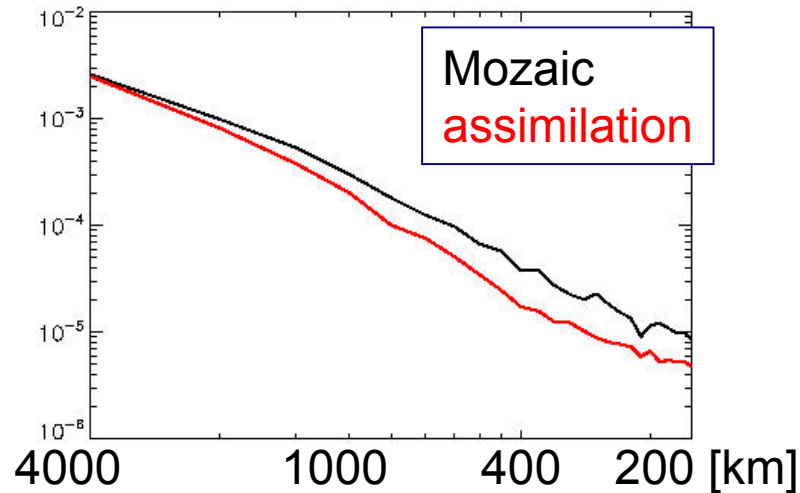


Aircraft data exhibit larger variability at small scales, even after averaging



A compactly supported Gaussian-like smoother decreases variability of aircraft data. Here 480 km smoothing is applied

Impacts of Smoothing MOZAIC



Summary

How does ozone structure arise?

- Assimilation constrains the largest scales and transport introduces structure

What scales are reasonably captured?

- Assimilation captures scales of about 480km (about six grid boxes in GEOS-4) - consistent with model transport

Implications:

- Structure in the stratospheric ozone analyses depends on accuracy of transport in the model
- Tropospheric constituent assimilation: the nature of transport (and its error) as well as the observations are very different from the stratosphere